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ERRATUM

SPECIFICATION NO 2153410A

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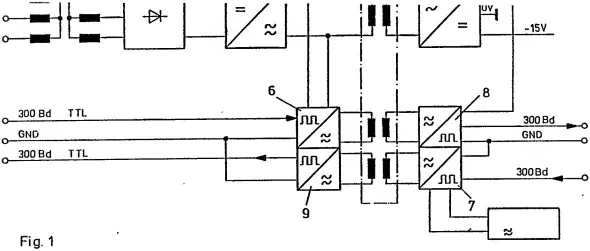

Fig. 1

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(54) Inductive data and energy transmission system

(57) An inductive data and energy transmission system for use in a bore hole arrangement made up of individual lengths of drill pipe connected together comprises parts of an inductive coupling system 4 included in the connection between two pipe lengths. The parts are so arranged that when connection has been made between two pipe lengths, a complete inductive coupling 4 is formed.

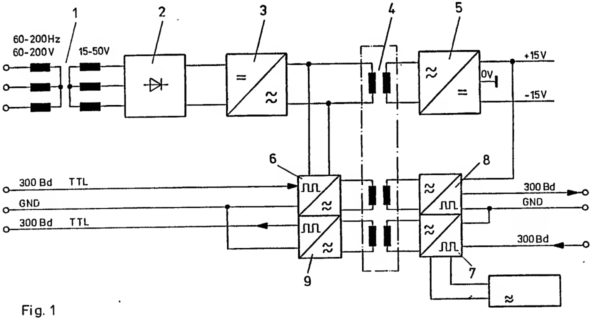

Fig. 1

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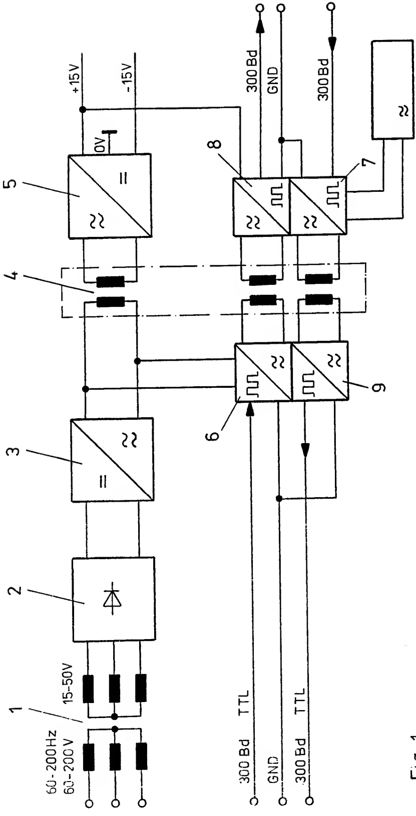

Fig 1

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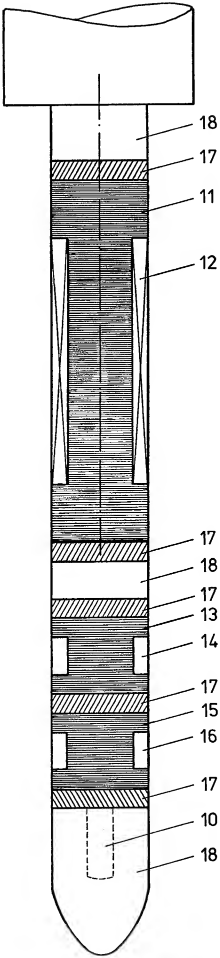

Fig. 2

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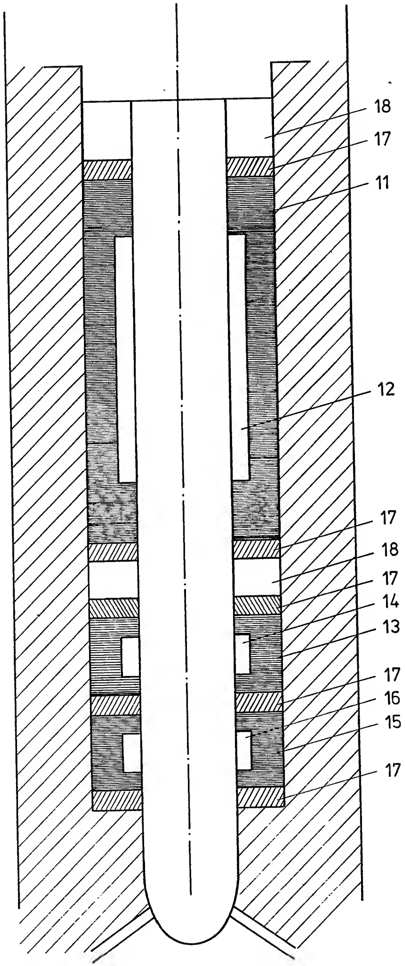

Fig. 3

SPECIFICATION

Inductive data and energy transmission system

The invention relates to an inductive data and energy transmission system for use in a bore arrangement made up of individual lengths of pipes connected together.

Lowerable measuring devices are used for the monitoring of partially elongated structures. As an example, a pipe line borehole may be mentioned, which extends from a ship to the bottom of the sea and into the underlying strata. The whole arrangement may serve for the exploration for and conveyance of hydrocarbons. Depending on the sensor unit used, data, such as orientation of the borehole and change of inclination, formation characteristics, drilling parameters and the state of the borehole can be ascertained. These data are remotely transmitted to the operator's desk.

The expression "Measurement While Drilling" (MWD) covers not only the collection of measured values underground together with their remote transmission but also the recording of these data above ground, which are necessary for the optimization of the drilling operation.

With the rise of oil prices in the seventies, various projects were begun by several firms under the names "Logging While Drilling" (LWD), "Downhole Logging While Drilling" (DLWD), or "MWD". In the majority of cases, these were not conceived, as earlier, as competitors to the conventional Schlumberger Logging, but for measurements of borehole orientation data for carrying out directional drilling projects. The term "MWD" was accepted by the industry as meaning that any measurable variable from the bottom of the borehole which is transmitted to the surface is included.

The reasons for the natural drift of the course of the borehole from its planned course are to be found in a change in the rock characteristics or the collapse of the geological strata and the drill stem behaviour. The knowledge of such a drillhole shape and its coordinates depends on the frequency of the measurements and the accuracy of the measuring system used. The nature, location and object of the drilling programme generally determine the planned maintenance costs. For a drilling project, optimum degrees of accuracy for the information needed have to be defined, as appear necessary for reliable execution without additional risks while minimizing the periods of non-use of the derrick and measuring costs. This expense has to be compared with the benefit to be expected, which results from the use of more accurate systems and has to be included in the decision process for the selection of a MWD system. The accuracy of these systems is limited not so much by difficulties in technical realization as by high financial expense.

The actual measuring devices are located inside a non-magnetizable drill stem above the bit or the direct drive for the bit. The measuring devices and the processors (microcomputers) are accommodated in a sensor pack which is either built in or, with certain systems, can be installed underground by means of suitable devices if necessary.

The sensor pack comprises the actual measuring member, the sensor or measured-value pick-up, the measured-value processing device and the transmission element which "telemeters" the coded quantities to the surface by means of a transmission medium. Modern sensors for directional drilling work measure the inclination of the borehole by means of three "accelerometers" aligned at right angles to one another, formerly by means of a pendulum whose position was measured electronically or mechanically. The direction is generally measured by means of three magnetometers. The orientation of a change of inclination of a mud motor can be determined by means of magnetic or gravitational methods.

Because of the environmental requirements, these sensor packs are very expensive and are therefore constructed so that they can be installed in and removed from the borehole; this requires plug connections.

If plug connections are selected for the connection, as described in the Christensen printed document of May 1982, then there is a danger that these may very easily become soiled and so cause multiple disturbances in the data transmission and lead to a considerable reduction in operational reliability. The majority of metal plug connections corrode very quickly under the given environmental conditions.

The invention therefore seeks to provide a transmitter which is not very susceptable to trouble and can ensure a reliable transmission of data and energy.

According to the invention there is provided an inductive data and energy transmission system for use in a bore arrangement made up of individual lengths of pipe connected together, wherein the parts of the connection between two pipe lengths include parts of an inductive coupling such that when the connection between the two pipe lengths has been made, a complete inductive coupling is formed.

As a result of the inductive transmission of the data, a transmission independent of the state of the metal contact surfaces is achieved. In this respect, it resembles the toroidal-core tranducers frequently used, with the advantage that the establishment of the connection can be effected considerably faster and more simply.

The invention will now be described in greater detail by way of example, with reference to the drawings, in which:—

Figure 1 shows a circuit arrangement of an energy and data transmission arrangement, and

Figures 2 and 3 show the basic construction of a transmitter.

According to the circuit diagram shown in Figure 1, the supply voltage is delivered by a turbine generator and fluctuates within wide limits with corresponding proportional frequency changes. This voltage is supplied via a transformer 1 to the secondary winding of which a rectifier 2 is connected which in turn feeds an inverter 3. The

voltage delivered from the output of the inverter 3 has a constant frequency of about 10 kHz with a constant amplitude.

This alternating voltage is transmitted by means of a transmitter 4 to be described in more detail later, to the length of pipe extending therebeyond. A rectifier with supporting capacitors (not shown) feeds a synchronized power supply unit 5, the output voltage of which amounts to ±15 V with a rated current of 1 A.

Data transmission is effected by means of a carrier-frequency modulation, each direction being given its own frequency, the spacing between which is selected so that no coupling worth mentioning occurs. The frequency spacing from the frequency of the energising current is also selected to be sufficiently large. The pulse trains are each converted into alternating voltages in a converter stage 6, 7, transmitted to the transmitter 4 and converted back into trains in the stages 8, 9 at the secondary side.

The transmitter comprises a plug pin as shown in Figure 2, and a plug socket as shown in Figure 3. With a frequency of 10 kHz, the core should be laminated from dynamo sheet in order to keep the eddy current losses low. Therefore, as shown in Figure 2, three core portions, which are separate from one another, are located on a threaded pin 10, of which the portion 11 with a coil 12 serves for the energy transmission, the portion 13 with a coil 14 serves for the data transmission in the one direction and the portion 15 with a coil 16 serves for the data transmission in the other direction. The core portions with the associated coils are separated from one another by insulating washers 17 for magnetic decoupling. Furthermore, guide washers 18 are provided, distributed in the plug and socket for the reliable guiding of the pin and are provided with a thread and push the core laminations together. Connection wires for the coils are laid in a groove in the threaded pin 10.

CLAIMS

1. An inductive data and energy transmission system for use in a bore arrangement made up of individual lengths of pipe connected together, wherein the parts of the connection between two pipe lengths include part of an inductive coupling such that when the connection between two pipe lengths has been made, a complete inductive coupling is formed.

2. A system as claimed in claim 1, wherein the inductive coupling is in the form of a plug and socket connection, one or more coils on the plug cooperating with one or more coils respectively in the socket.

3. A system as claimed in claim 1 or 2, wherein, for energy transmission, the voltage of an energy generator is supplied to a rectifier feeding an inverter, the output voltage of which is supplied via the inductive coupling to a synchronised power supply unit in a following length of pipe.

4. A system as claimed in claim 1, 2 or 3, wherein data transmission in two directions and the energy transmission are carried out at different frequencies, the spacing of the frequencies being selected such that coupling between the various transmissions is minimal.

5. A system as claimed in any one of claims 1 to 4, wherein each part of the transmitter comprises a core of laminated dynamo sheet iron and an intermediate insulating layer is provided for magnetic decoupling of coils provided on the core.

6. A system as claimed in claim 5, wherein the laminations are held together under pressure by means of screwable washers.

7. A system as claimed in claim 5 or 6, wherein, with a plug or socket connection, connecting wires for the coils of the plug are laid in a groove in a central threaded rod.

8. An inductive data and energy transmission system substantially as described herein with reference to the drawings.

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